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Clustering of risk factors for chronic diseases among adolescents from Southern Brazil

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ABSTRACT

Objective. To investigate the clustering of risk behaviors for chronic non-communicable diseases and their associated factors among adolescents from Southern Brazil.

Methods. In 2008, a survey was conducted with 3990 adolescents aged 14–15 years (mean: 14.3; SD: 0.6) from the 1993 Pelotas Birth Cohort Study. Clustering was determined by comparing observed (O) and expected (E) prevalence of all possible combinations of the four risk factors investigated (smoking, alcohol intake, low fruit intake, and physical inactivity). We carried out Poisson regression to evaluate the effect of individual characteristics on the presence of at least three risk behaviors.

Results. All risk factors tended to cluster together (O/E prevalence = 3.0), especially smoking and alcohol intake (odds ratio to present on behavior in the presence of other > 5.0). Approximately 15% of adolescents displayed three or more risk behaviors. Females (adjusted OR = 1.55), people 15 years and older (OR = 1.47), with black skin color (OR = 1.23), and of low socioeconomic level (OR = 1.29) were more likely to display three or more risk factors.

Conclusion. These findings suggest that lifestyle-related risk factors tend to cluster among adolescents. Identifying subgroups at greater risk of simultaneously engaging in multiple risk behaviors may aid in the planning of preventive strategies.

Introduction

According to the World Health Organization (WHO), chronic non-communicable diseases (CNCDs) account for approximately 60% of all deaths worldwide, and for 46% of the global burden of disease (WHO, 2005). Over one third of all deaths globally are due to a small group of risk factors. Smoking, physical inactivity, alcohol abuse, and insufficient intake of fruit and vegetables are some of the major modifiable risk factors that account for most CNCD deaths and for a substantial fraction of the associated disease burden (WHO, 2005).

Even though CNCDs emerge mostly during adult life, many of their precursors are present during childhood and adolescence. This is a reason for concern given that behaviors acquired during these early stages tend to remain through adulthood (Mikkila et al., 2004; Ness et al., 2005). Furthermore, studies suggest that these factors tend to occur simultaneously which has important health implications in the long, medium, and short terms.

Although a large number of studies have addressed the prevalence of isolated risk behaviors for chronic diseases, few studies have evaluated the coexistence of risk factors, especially in adolescents. Most studies in the international literature that investigate clusters of behaviors were done on adult populations (Poortinga, 2007; Schuit et al., 2002), with a small fraction of these investigating adolescents in high-income countries (Alamian and Paradis, 2009; Andersen et al., 2003; Lawlor et al., 2005). We were unable to find studies that evaluate clusters of risk behaviors among adolescents in Brazil.

Given that interventions addressing multiple behaviors have greater impact than those aimed at isolated behaviors (Goldstein et al., 2004; Nigg et al., 2002), cluster analysis of risk factors for chronic diseases may aid in the planning of intervention programs. The present study was aimed at investigating clusters of four risk behaviors (smoking, alcohol intake, low fruit intake and physical inactivity) for chronic diseases as well as association with socio-demographic factors among adolescents from Southern Brazil.

Methods

The subjects in the present study were adolescents belonging to the 1993 Pelotas Birth cohort. Pelotas is a medium-sized city in Southern Brazil with a population of approximately 340 thousand. The present study evaluated the 2008 follow-up when subjects were aged 14–15 years (mean 14.3; SD 0.6). During this follow-up, we traced 4325 of the original 5429 subjects, an 82.5% follow-up rate when considering the 147 known deaths. Additional information on the methods of the cohort study can be found elsewhere (Araujo et al., 2010; Victora et al., 2008).

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The four behavioral risk factors investigated were defined as follows:

a) Smoking: having smoked at least one cigarette in the last 30 days (Malcon et al., 2003). This information was obtained by means of a confidential questionnaire administered to the adolescent.
b) Alcohol intake: having ingested an alcoholic beverage at least once in the last 30 days (Strauch et al., 2009). This information was also obtained by means of a confidential questionnaire.
c) Low fruit intake: having consumed fruit less than once a day. This information was obtained using the Block questionnaire (Thompson and Byers, 1994).
d) Physical inactivity: having performed less than 420 minutes of activity per week, equivalent to 60 minutes per day of physical activity, according to recommendations for children and adolescents (Strong et al., 2005).

Statistical treatment

Risk behaviors were coded as a binary variable (presence = 1; absence = 2). Prevalence of multiple risk behaviors was estimated based on the sum of individual behaviors, which generated a score ranging from 0 to 4 (0 = no risk factors; 4 = all four risk factors) based on the distribution observed in the sample.

The present analysis was carried out in three stages. First, we analyzed the cluster of risk factors, stratified by sex. Clustering occurs when the observed prevalence of a combination of factors exceeds the expected prevalence for this combination. Expected prevalence for a given combination is calculated by multiplying the individual probabilities of each behavior based on their observed occurrence in the survey. Observed/expected (O/E) ratios higher than 1 are indicative of clustering (Galan et al., 2005; Schuit et al., 2002). The 95% confidence intervals (95%CI) were obtained by binomial exact probability (Daly, 1992).

Second, odds ratios (OR) were used to calculate the clustering of two behaviors in the presence of another risk behavior. The OR represents the additional estimate that one behavior may have in relation to the other, and is calculated using the equation below (Schuit et al., 2002):

$$N_{11} \times N_{00} / N_{10} \times N_{01}$$

where N_{11} is the number of responders displaying both risk factors, N_{00} is the number of respondents without any of the risk factors, N_{10} is the number of respondents displaying only one risk factor, and N_{01} is the number of respondents displaying the other risk factor.

For example, an OR of 1.5 indicates that subjects displaying a given behavior (e.g. physical inactivity) are 1.5 times more likely to display another behavior (e.g. low fruit intake) when compared to those not exposed to the first behavior (physical inactivity).

Third, for multivariate analysis, we carried out a Poisson regression with presence of at least three risk behaviors as the outcome and the following demographic variables as exposures: sex (male, female); age in years (14.0–14.4; 14.5–14.9; 15.0–15.5); skin color (white, black, mixed); assets index in terciles based on principal component analysis of the ownership of a series of domestic goods and characteristics of the residence (Araujo et al., 2010); and mother's schooling in completed years (0 to 4; 5 to 8, 9 to 11, 12 or more). These variables were adjusted for each other.

We adopted a 5%, two-tailed significance level. Statistical analysis was carried out using Stata, v. 11.0 software. The study protocol was approved by the Research Ethics Committee of the Federal University of Pelotas School of Medicine (process no. 158/07).

Results

Of the 4325 adolescents interviewed, 3990 (92.3%) provided complete information for all four outcomes. There were no differences between the overall sample and those who were included in the analyses, in terms of sex, age, skin color, asset index, and mother schooling (data not shown). Of these, 51% were female, 17% had already completed 15 years of age, 66% were white, and 12% were the children of mothers with 12 or more years of schooling. In total, 6% of adolescents were smokers, 25% had ingested alcohol within the last month, 70% were physically inactive, and 72% did not eat fruit on a daily basis. Prevalence of smoking, alcohol intake, and physical inactivity was greater among females, whereas low fruit intake was more prevalent among males (Table 1). The distribution of risk factors was as follow: 30.8% presented one risk factor, 48.2% two, 12.4% three, and 2.1% presented the four characteristics analyzed. Only 6.5% of the sample did not display any of the risk factors analyzed.

Table 2 shows the observed and expected prevalence of the 16 possible combinations of the four behaviors investigated. Observed prevalence of all four behaviors together was higher than that expected based on the individual probability for each factor. This effect was slightly stronger among males (O/E prevalence = 3.6) than among females (O/E prevalence = 2.4). The combination of smoking with alcohol intake was noteworthy in that its observed prevalence was higher than expected in both sexes. There was also a clustering for smoking, alcohol intake and physical inactivity for males (O/E prevalence = 3.3) and for smoking, alcohol intake and low fruit intake for females (O/E prevalence = 3.4). The O/E ratio for most other combinations was close to 1 (Table 2).

Clustering for pairs of risk factors is presented in Table 3. It is clear that risk of smoking is markedly higher for adolescents who consume alcohol, especially among males. Among females, there was a protective effect of physical inactivity on alcohol intake, that is, girls who are more physically active are more likely to consume alcohol. Also among girls, low fruit intake clustered with physical inactivity, that is, girls displaying one of these behaviors were more likely to display the other as well. These associations remained significant even after adjustment for socioeconomic level (data not shown).

Table 4 shows the association between demographic/socioeconomic variables and presence of at least three risk behaviors (prevalence = 14.5; 95%CI: 13.4–15.6). Female sex, having completed 15 years, black skin color, and lower socioeconomic level were associated with displaying at least three risk behaviors, in both crude and adjusted analyses. There was no association with maternal schooling.

Discussion

In the present study, we investigated the prevalence and clustering of the four most important behavioral risk factors for the development of CNCDs, namely smoking, alcohol intake, physical inactivity, and low fruit intake (WHO, 2005). Our results show that, with the exception of smoking, the remaining factors were present among both boys and girls at frequencies higher than 20%. Factors such as physical activity and low fruit intake were present in more than half of the studied population. We also show that these risk factors tend to cluster together. This was particularly the case for smoking and alcohol intake, which were more frequent among male adolescents.

Interest in the prevalence of risk factors for CNCDs among adolescents has increased considerably in the last decade (Beck et al., 2011; Christofaro et al., 2011; Farias Júnior et al., 2011; Romanzini et al., 2008). One of the reasons behind this increase is the fact that defining the early risk profile may help to design public measures aimed at preventing these behaviors, especially measures combining health and

Table 1
Description of risk behaviors among adolescents from the 1993 Pelotas (Brazil) Birth Cohort study: 2008 follow-up ($n = 3990$).

Variables	All (%)	Males (%)	Females (%)	p-Value[a]
Smoking	5.7	4.5	6.9	0.001
Alcohol intake	24.8	22.5	26.9	0.001
Low fruit intake	71.8	73.5	70.3	0.03
Physical inactivity	70.4	56.4	86.5	<0.001
Number of risk factors				<0.001
0	6.5	9.7	3.6	
1	30.8	36.6	25.3	
2	48.2	42.3	53.8	
3	12.4	10.0	14.7	
4	2.1	1.5	2.7	

[a] Chi-squared test for difference between sexes.

Table 2
Prevalence and associated factors for four risk behaviors, stratified by sex, among adolescents from the 1993 Pelotas (Brazil) Birth Cohort study: 2008 follow-up.

Risk factors	Smoking	Alcohol intake	Low fruit intake	Physical inactivity	Males ($n=1936$)			Females ($n=2054$)		
					O (%)	E (%)	O/E (95%CI)	O (%)	E (%)	O/E (95%CI)
4	+	+	+	+	1.5	0.4	3.6 (2.8–4.5)	2.7	1.1	2.4 (1.8–3.1)
3	+	+	+	−	0.6	0.3	1.8 (1.3–2.5)	0.6	0.2	3.4 (2.7–4.3)
	+	+	−	+	0.5	0.2	3.3 (2.6–4.2)	0.7	0.5	1.5 (1.0–2.1)
	+	−	+	+	0.7	1.4	0.5 (0.3–1.0)	1.5	3.1	0.5 (0.2–0,9)
	−	+	+	+	8.2	8.9	0.9 (0.5; 1.4)	11.9	15.2	0.8 (0.5; 1.3)
2	+	+	−	−	0.3	0.1	2.6 (1.9–3.4)	0.3	0.1	4.0 (3.2–;4.9)
	+	−	−	+	0.3	0.5	0.6 (0.3–1.1)	0.6	1.3	0.5 (0.2–0.9)
	+	−	+	−	0.6	1.1	0.5 (0.3–1.0)	0.2	0.5	0.4 (0.2–0.8)
	−	+	+	−	6.8	6.9	1.0 (0.6–1.5)	3.3	2.4	1.4 (1.0–2.0)
	−	+	−	+	2.5	3.2	0.8 (0.4–1.3)	5.9	6.4	0.9 (0.5–1.4)
	−	−	+	+	31.9	30.7	1.0 (0.6–1.5)	43.5	41.4	1.1 (0.7–1.7)
1	+	−	−	−	0.2	0.4	0.5 (0.3–1.0)	0.3	0.2	1.5 (1.0–2.1)
	−	+	−	−	2.3	2.5	0.9 (0.5–1.4)	1.6	1.0	1.6 (1.1–2.2)
	−	−	+	−	23.2	23.7	1.0 (0.6–1.5)	6.7	6.5	1.0 (0.6–1.6)
	−	−	−	+	11.0	11.1	1.0 (0.6–1.5)	16.8	17.5	1.0 (0.6–1.6)
0	−	−	−	−	9.7	8.6	1.1 (0.7–1.7)	3.6	2.7	1.3 (0.9–1.9)

O: observed; E: expected.
+ Factor present ; − Factor absent.

educational interventions. One of the strengths of the present study is that it investigates clusters of CNCD risk factors, in contrast to most other surveys with adolescents, which focus on isolated behaviors. Furthermore, most studies investigating clusters of risk factors were done on adult populations (Poortinga, 2007; Schuit et al., 2002), and the few that include adolescents were carried out in high-income countries (Alamian and Paradis, 2009; Andersen et al., 2003; Lawlor et al., 2005).

Despite its innovative approach, the present analysis has certain limitations, which should be considered. Given that our study was based on a birth cohort, the extrapolation of these results to adolescents in general must be done with caution, given the narrow age range covered. Another limitation is the low prevalence of smoking in the present survey, which differs from that detected in most other studies with adolescents (Beck et al., 2011; Horta et al., 2007). It is important to bear in mind that this may be the result of omission of smoking habits by some of the subjects. Even though questionnaires were confidential, it is possible that subjects may have been hesitant to report the use of tobacco. Such a trend was reported in another survey that measured cotinine levels among students in the same city (Malcon et al., 2008). This study showed poor agreement between self-reported smoking and cotinine levels, suggesting that adolescents underreported cigarette smoking (Malcon et al., 2008). However, a potential impact of the anti-smoking campaigns and legislation implemented over the last decade should not be discounted. Another limitation is that we did not investigate the intake of vegetables since this information was not covered by the questionnaires used in the survey. We also highlight the fact that information on physical activity was also self-reported, which may lead to overestimation. The criterion used to define alcohol intake was highly sensitive, as the prevalence of adolescents who ingested alcohol on a daily basis was very low. Finally, the use of a cut-off point to analyze the risk factor score may be controversial. However, we analyzed the chance to present one more risk factor, through ordinal analyses, and the results were similar (data not shown).

Studies investigating the clustering of risk factors for chronic conditions vary greatly as to the sets of factors under study, which makes comparisons between different studies difficult. It should be noted that biological risk factors (high arterial pressure, hypercholesterolemia, among others) are at the core of most CNCD risk factor clustering studies, especially those focusing on cardiovascular disease. In the present study, however, we placed greater emphasis on behavioral risk factors, given the evidence that lifestyle variables have a greater tendency to cluster and are potentially modifiable (Schuit et al., 2002). We highlight the important clustering effect for smoking and alcohol intake found in the present study. This finding underscores the importance of educating adolescents as to the importance of avoiding such behaviors, since one behavior leads to the other, as well as to the intake of heavier drugs. We also demonstrate the clustering of these both behaviors (smoking and alcohol) with low fruit intake among girls and with physical inactivity among boys. Special attention should be given to adolescents from poorer families, since this group was more vulnerable to displaying three or more risk factors for CNCDs.

Our results may have important implications in terms of health policy and practice given that the high prevalence of multiple CNCD risk factors underscore the importance of interventions aimed at their reduction. Adolescence is a period in which lifestyle habits are being formed and consolidated. Many of the behaviors acquired during adolescence tend to remain through to adult life, with important implications for adult health. Given that behavioral risk factors such as those investigated in the present study are potentially modifiable, identifying subgroups that are at higher risk of simultaneously displaying multiple factors is of extreme importance if we wish to reduce propensity to chronic diseases in adult life.

Table 3
Odds ratios (OR) for displaying two risk behaviors, stratified by sex, among adolescents from the 1993 Pelotas (Brazil) Birth Cohort study: 2008 follow-up.

Risk factor combination	Males ($n=1936$)				Females ($n=2054$)			
	%	OR[a]	95%CI	p^*	%	OR[a]	95%CI	p^b
Smoking and alcohol	2.8	6.3	4.0–9.8	<0.01	4.3	5.2	3.7–7.5	<0.01
Smoking and low fruit intake	3.4	1.1	0.7–1.8	0.8	5.0	1.1	0.8–1.6	0.5
Smoking and physical inactivity	2.9	1.4	0.9–2.2	0.1	5.5	0.8	0.5–1.2	0.2
Alcohol and low fruit intake	17.1	1.2	0.9–1.5	0.2	18.5	0.9	0.7–1.1	0.3
Alcohol and physical inactivity	12.6	1.0	0.8–1.2	0.8	21.2	0.6	0.5–0.8	<0.01
Physical inactivity and low fruit intake	42.2	1.2	1.0–1.5	0.1	59.5	1.3	1.0–1.7	0.03

[a] Reference category is those not exposed to the first risk factor.
[b] Chi-squared test.

Table 4
Crude and adjusted analysis of the association between demographic and socioeconomic variables and presence of three or more risk behaviors (smoking, alcohol intake, physical inactivity, and/or low fruit intake), among adolescents from the 1993 Pelotas (Brazil) Birth Cohort study: 2008 follow-up ($n = 3990$).

Characteristics[a]	*n*	Crude analysis		Adjusted analysis[b]
		%	PR (95%CI)	PR (95%CI)
Sex				
Male	1936	11.4	1.00	1.00
Female	2054	17.4	1.52 (1.30–1.78)	1.55 (1.32–1.84)
Age (years)				
14.0–14.4	1225	12.2	1.00	1.00
14.5–14.9	2074	14.0	1.15 (0.95–1.38)	1.17 (0.96–1.41)
15.0–15.5	686	19.8	1.62 (1.31–2.00)	1.47 (1.17–1.86)
Skin color				
White	2539	13.6	1.00	1.00
Mixed	574	14.6	1.08 (0.87–1.35)	1.03 (0.82–1.30)
Black	729	17.3	1.28 (1.06–1.54)	1.23 (1.01–1.50)
Assets index (terciles)				
1 (lowest)	1309	17.5	1.32 (1.10–1.58)	1.29 (1.03–1.61)
2 (middle)	1338	12.5	0.94 (0.77–1.15)	0.95 (0.77–1.18)
3 (highest)	1326	13.3	1.00	1.00
Mother's schooling (years)				
0 to 4	842	14.9	0.99 (0.76–1.31)	0.83 (0.60–1.13)
5 to 8	1555	14.3	0.96 (0.75–1.24)	0.84 (0.63–1.11)
9 to 11	879	13.2	0.88 (0.67–1.17)	0.84 (0.63–1.12)
12 or higher	442	14.9	1.00	1.00

PR: Prevalence ratio; CI: Confidence interval.
[a] Mother schooling had 6.8% of missing values; and skin color had 3.7%. Assets index and age had less than 1%.
[b] Adjusted for the variables in the table.

Conflict of interest statement

None.

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